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Fire and Fuels Report

Little Deer Project

Goosenest Ranger District, Klamath National Forest
Siskiyou County California

For Information Contact: Ron McEwen
37805 Highway 97, Macdoel, CA 90658
530-398-5731

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Executive Summary

Methodology

The Forest Plan requires the analysis of fuel accumulation over time (standard 22-16, page 4-55). Standard 22-22 (Forest Plan, page 4-55) requires that the hazard, risk and consequences of a wildfire be analyzed. The 40 standard fire behavior fuel models are used as the basis for this analysis of indicators measuring the effects of this project on fire and fuels (Scott and Burgan 2005); more information on these fuel models is provided in the fire and fuels resource report on the project website. Fire behavior fuel models are based on the physical and vegetative characteristics of an area (including fuel loads) and predict, among other outputs, the flame lengths of a wildfire under various weather and fuel moisture conditions.

The analyses of long-term effects are based on professional judgment. Acreage dominated by each of the fuel models are identified using GIS layers (LANDFIRE remotely sensed fuel models) as a coarse filter. Field visits to potential treatment areas verified fuel models. To refine fuel models, field visits were used to make final determinations of the fuel model.

Analysis Indicators

The first indicator in this analysis is flame length, as predicted for each standard fire behavior fuel model under the modeled fuel moisture and weather scenario most similar to local 90th percentile weather and fuel moisture conditions. Flame length directly affects fire suppression tactics and capabilities, and is thus an important indicator of the likelihood of successful fire control efforts. Flame length is analyzed using four categories corresponding to the effort and resources required to attack a fire. Flame length is a measure of fire intensity, which in turn affects fire severity (i.e. vegetation mortality). This is described in more detail on tables 1 and 2 of the Fire and Fuels resource report, available on the project website.

The second indicator is fuel loading (in material less than 3 inches in diameter) as determined by the standard fire behavior fuel models (Scott and Burgan 2005). The following identifies the fuel models in the project area:

- NB9 (99) – Bare Ground.
- GR1 (101) - Short, sparse dry climate grass.
- GS2 (122) - Moderate load, dry climate grass-shrub.
- SH1 (141) - Low load dry climate shrub.
- SH2 (142) - Moderate load dry climate shrub.
- SH5 (145) - High load, dry climate shrub.
- TU5 (165) - Very high load, dry climate timber-shrub.
- TL1 (181) - Low load compact conifer litter.
- TL8 (188) - Long-needle litter.

Fuel loading in material less than 3 inches in diameter has a direct effect on fire behavior; this makes it a useful indicator of fuel reduction effectiveness.

Fuel loading of material greater than 3 inches in diameter has a different effect from that of smaller material as this larger material takes longer to ignite and is likely to result in slower burning. These larger fuels (greater than 3 inches in diameter) reduce fire behavior overall, but fuel loading of these materials is a useful measure of fuel reduction effectiveness because of the potential effects to soils and suppression efforts. Fuels greater than 3 inches will burn for longer periods of time, causing additional heat transfer to the soil and increased potential for soil sterilization. Suppression efforts are more difficult because these larger fuels create an obstacle and safety hazard for fire personnel; often removal of these fuels is necessary to construct control lines. Longer burning times require additional effort to secure control lines and increase the potential for spot-fires. High large fuel loads reduce suppression resource effectiveness and the safety of firefighting resources.

For the purpose of this analysis, under normal conditions (natural fire regimes) fuel loading for early and mid-succession vegetation ranges from 1.5 to 10 tons per acre (LANDFIRE 2007, Anderson 1982). Excess fuel loads of material greater than 3 inches in diameter are represented by 10 tons per acre or greater.

Fire severity is the third indicator and is represented by differences in fire severity acreage as determined by professional assessment of flame lengths predicted under the modeled fuel moisture and weather scenario most similar to local 90th percentile conditions using the standard fire behavior fuel models (Scott and Burgan 2005). Fire severity describes the effects of fire on vegetation should a wildfire occur. It is related to vegetation mortality expected during a wildfire. For this analysis, fire severity is rated as high or low. Low fire severity is the result of low flame lengths (generally less than 8 feet in timber fuel types). This resembles an underburn with ground vegetation burned but large conifers remaining alive. High fire severity is the result of high flame lengths (generally more than 8 feet in timber fuel types). High severity fire kills nearly all of the large conifers and may lead to reduced re-sprouting of brush. Table S-1 displays fuel loads (in material less than 3 inches in diameter), flame lengths and predicted severity for each of the various fuel models.

Table S-1: Fuel load (material less than three inches in diameter), predicted flame length, and predicted severity by fuel model

Fuel Model	Total Fuel Load of material <3" in diameter in tons/acre	Flame Length in feet	Predicted Severity
NB9 (99)	0	0	N/A
GR1 (101)	0.4	2.5	Low
GS2 (122)	2.6	8.5	High
SH1 (141)	1.95	0.9	Low
SH2 (142)	8.35	7.0	Low
SH5 (145)	8.6	21.0	High
TU5 (165)	14	11.0	High
TL1 (181)	6.8	0.8	Low
TL8 (188)	8.3	5.8	Low

Spatial and Temporal Context

Spatial boundaries, for direct and indirect effects, will be limited to acres treated because it is on these acres that fuel models are predicted to change. Spatial boundaries for cumulative effects will be limited to the project area because the fuels models in the project area may be affected by current and reasonable foreseeable future actions surrounding the treatment areas. Temporal bounding for effects extends 40 years following treatment because this is required in the Forest

Plan (standard 22-16, page 4-55). Effects will be modeled immediately after treatment, 20 years after treatment, and 40 years after treatment. Effects immediately after treatment will be considered short-term effects. Effects at 40 years are considered long-term effects.

Affected Environment

Vegetation in the project area prior to the Little Deer fire is discussed in the Vegetation section; pre-fire fuel models based on this vegetation were altered by past timber harvest and fire suppression causing predicted high severity fire effects throughout the project area. The historical condition of fire and fuels in the project area is described in detail in the Fire and Fuels resource report. Most of the project area historically supported fire return intervals of 13 years resulting in low fuel loads, low flame lengths, and low fire severity. When the Little Deer fire occurred, the area had missed several fire return intervals. With the exclusion of frequent fires, stands attained fuel loads represented by high severity fuel models, providing conditions conducive to wildfires such as the Little Deer fire that exhibited high flame lengths and high severity fire effects.

The post-fire landscape is comprised of bare ground (fuel model NB9), sparse grass (GR1), and low load compact conifer litter (TL1). About 46 percent of the project area burned with high severity effects and 36 percent with moderate severity effects. About 28 tons per acre of dead trees greater than three inches in diameter are estimated to be scattered throughout the project area based on conditions measured after the nearby 2009 Tennant fire.

Environmental Consequences

This section analyzes the effects that each alternative has on the acreage occupied by each fuel model, and the relationship of these acreages to the three analysis indicators (flame lengths, fuel loads, and fire severity).

Alternative 1

Direct Effects and Indirect Effects

Under alternative 1 there will be no project actions taken and, as noted in the Vegetation section, vegetation will continue to be dominated by shrubs and conifer re-establishment will be slow for an extended time period. Potential high severity unplanned fires will promote continued dominance of shrubs until a seed source for conifers can become established. With no treatment, bare ground moves to moderate load grass-shrub (GS2), then to high load shrub (SH5). Sparse grass moves to moderate load shrub (SH2), then to high load shrub. Low load compact conifer litter moves either to low load shrub (SH1) then to high load shrub, or to long needle litter (TL8) then to very high load timber-shrub (TU5) as displayed in tables 4A through 4C of the Fire and Fuels resource report.

Based on mortality and snag fall observed after the 2009 Tennant fire, it is estimated that 60 percent of pine snags in the Little Deer project area will fall to the ground in five years. There will be at least 28 tons per acre of dead material greater than three inches in diameter from fire-killed trees with a total of 116,200 tons in the project area. As snags fall and woody material decomposes, some of the larger diameter material (greater than 3 inches) will be converted to dead fuels which are slow to ignite; this will generally result in low fire severity to vegetation but higher severity to soils. Fuel loads for dead material less than 3 inches in diameter relate directly to fire behavior within the flaming front of the fire. Increases in these fuels generally result in an increase in fire severity, in suppression effort needed to control fires, and in the potential for passive and active crown fires. An increase in potential for crown fires increases the potential for mortality due to crown consumption (Brown and Kapler 2000). Table S-2 displays the flame lengths, fuel loads and fire severity that are likely in the short term and long term with alternative 1.

Table S-2: Flame-lengths, fuel loads, and fire severity currently, after 20 years, and after 40 years for alternative 1

Weighted Averages	Flame Length (Feet)	Fuel Load (Tons Per Acre <3”)	Fuel Load (Ton Per Acre >3”)	Percentage of High Severity Acres
Current	0.8	6.3	0	0%
After 20 years	2.9	4.0	24	6%
After 40 years	18.0	10.2	18	100%

Cumulative Effects

The effects of past actions have been included in the description of the affected environment. There are some reasonable foreseeable future actions within the project area that will result in reduced potential for high intensity wildfires; these are limited to areas in and around the other vegetation treatments on private lands. For example, salvage harvest and live tree planting is likely to be implemented on private land; the potential for high intensity wildfire is likely to decrease around these private lands if trees outcompete and shade brush, especially if herbicides are used to the eliminate brush on these private lands. The impacts of ongoing cattle grazing in the Horsethief grazing allotment are considered in this cumulative effects analysis but grazing is not likely to have a measurable effect on the analysis indicators for fire and fuels and is not likely to contribute to changes in fire severity. There are no reasonable foreseeable future actions that will reduce the probability of fire entering the project area from outside. Adding the effects of alternative 1 to the effects of private land treatments and cattle grazing is not likely to produce substantial cumulative effects.

Alternative 2

Direct Effects and Indirect Effects

Proposed treatments for alternative 2 are described in chapter 2; effects on fire and fuels are summarized in table S-3. This alternative will remove an estimated 50,988 tons per acre of dead material greater than 3 inches from fire-killed trees from the total of 116,200 tons in the project area (43 percent removal). After browse species planting, bare ground moves first to moderate load shrub, then to high load shrub. After dead tree removal, reforestation and/or browse species planting, low load compact conifer litter moves either to very high load timber-shrub (resulting in high predicted fire mortality to planted conifers) or first to long needle litter, then to high load shrub as displayed in tables 5A through 5C of the Fire and Fuels resource report.

Table S-3: Flame lengths, fuel loads, and fire severity after treatment, after 20 years, and after 40 years for alternative 2

Weighted Averages	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fuel Load (Ton Per Acre >3")	Percentage of High Severity Acres
Current	0.8	6.4	0	0%
After 20 years	5.6	7.4	14	32%
After 40 years	15.2	11.7	10	100%

Cumulative Effects

Adding the effects of alternative 2 to the ongoing and reasonable foreseeable future actions described for cumulative effects of alternative 1 will not have substantial cumulative effects.

Alternative 3

Direct Effects and Indirect Effects

Proposed treatments for alternative 3 are described in chapter 2. The difference between the effects of alternatives 2 and 3 is due to less acreage being treated by dead tree removal, conifer reforestation, planting of browse species, and retention of additional snags being left on site in alternative 3. This alternative will remove an estimated 44,744 tons per acre of dead material greater than 3 inches from fire killed trees (38 percent removal), 6,244 less tons per acre than alternative 2. The effects of these treatments will be similar to those of alternative 2 as summarized in table S-4 and provided in more detail in tables 6A through 6C of the Fire and Fuels resource report.

Table S-4: Flame lengths, fuel loads, and fire severity immediately after treatment, after 20 years, and after 40 years for alternative 3

Weighted Averages	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fuel Load (Ton Per Acre >3")	Percentage of High Severity Acres
Current	0.5	3.7	0	0%
After 20 years	5.0	6.7	15	25%
After 40 years	15.9	11.4	10	100%

Cumulative Effects

Adding the effects of alternative 3 to the ongoing and reasonable foreseeable future actions described for cumulative effects of alternative 1 will not have substantial cumulative effects.

Comparison of Effects

In the short term, alternatives have little difference in flame lengths, fuel loads, or proportion of high fire severity due to all surface vegetation being removed by the Little Deer Fire, and post-treatment vegetation just beginning to establish. Alternative 2 has slightly higher fuel loads of small material and flame lengths due to a greater number of acres treated by dead tree removal, while alternative 3 has slightly lower fuel loads and flame lengths due to the lower acreage treated by dead tree removal. In the short term, all three alternatives will have flame lengths conducive to direct attack by hand crews, and will have only low severity fire effects across the landscape. Short-term effects of alternatives are displayed in table S-5.

Table S-5: Comparison of short term effects of alternatives on fire and fuel analysis indicators

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3”)	Fuel Load (Ton Per Acre >3”)	Acres of High Severity	Percentage of High Severity Acres
1	0.8	6.3	0	0	0%
2	0.8	6.4	0	0	0%
3	0.5	3.7	0	0	0%

After 20 years, Alternative 1 will have lower small-fuel loads, flame lengths, and fire severity risk on 63 percent of the project. Alternative 1 will be primarily a low severity brush fuel model type within the high severity burned conifer areas of the Little Deer Fire, with no new conifer establishment through artificial reforestation methods. Planting browse species within the conifer planting areas will create a high severity fuel model due to brush and trees being mixed together. Of the action alternatives, alternative 3 has slightly lower small-fuel loads, flame lengths, and acreage of high severity fire effects due to less acreage being artificially reforested and planted with browse specie; this results in less area dominated by fuel model TU5 (timber with shrub understory). Alternative 3 is expected to have fewer acres of high fire severity than alternative 2 due to a smaller amount of planting. Alternative 2 will have the lowest large fuel load followed closely by alternative 3 with alternative 1 having large fuel loads well in excess of normal conditions. Alternative 1 will have flame lengths conducive to direct attack by handcrews but will decrease firefighter effectiveness and safety. Alternatives 2 and 3 will require use of equipment to effectively suppress a fire, but will have increased firefighter effectiveness and safety. Mid-term effects of alternatives are displayed in table S-6.

Table S-6: Comparison of effects of alternatives on fire and fuel analysis indicators after 20 years

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3”)	Fuel Load (Ton Per Acre >3”)	Acres of High Severity	Percentage of High Severity Acres
1	2.9	4.0	24	226	6%
2	5.6	7.4	10	1334	32%
3	5.0	6.7	11	1091	25%

After 40 years, alternatives will have little difference in small-fuel loads, flame lengths, and proportion of high fire severity due to missing three fire return intervals, similar to conditions during the Little Deer Fire. The difference in flame lengths and fuel loads among the alternatives is primarily due to the different amounts of planting between alternatives 2 and 3; planting affects the ratio of brush and timber understory fuel models. Alternative 1 will still have the greatest large fuel load, in excess on normal conditions, with alternatives 2 and 3 being within normal conditions as summarized in table S-7. Firefighter effectiveness and safety will be greatest in alternatives 2 and 3 and least in alternative 1 although all three alternatives will have flame lengths exceeding the threshold for direct attack, and will have high severity fire effects across the entire landscape.

Table S-7: Comparison of effects of alternatives on fire and fuels analysis indicators after 40 years

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3")	Fuel Load (Ton Per Acre >3")	Acres of High Severity	Percentage of High Severity Acres
1	18.0	10.2	18	4155	100%
2	15.2	11.7	6	4150	100%
3	15.9	11.4	6	4179	100%

Compliance with law, regulation, policy, and the Forest Plan

All alternatives comply with laws, regulations, policy, and direction of the Forest Plan as they relate to the fire and fuels resource as displayed in the Forest Plan consistency checklist, available on the project website.

Fire and Fuels Resource Report

Methodology

Overview of Methodology

The Forest Plan requires the analysis of fuel accumulation over time including that generated by management activities (Standard and Guideline 22-16, pg. 4-55). Standard and Guideline 22-22 (Forest Plan, pg. 4-55) requires that the hazard, risk and consequences of a wildfire be analyzed for landscape scale projects. The standard fire behavior fuel models publication (Scott and Burgan 2005) is used as the basis for this analysis of indicators measuring the effects of fire and fuels. Fire behavior fuel models are based on the physical and vegetative characteristics of an area (including fuel loads) and predict, among other outputs, the flame lengths of a wildfire under various weather and fuel moisture conditions.

The analyses of long-term effects are based on professional judgment. Acreage dominated by each of the fuel models are identified using GIS layers (LANDFIRE remotely sensed fuel models) as a coarse filter. Project area field visits were used to make final determinations of fuel models. Based on professional judgment, the following assumptions were made regarding fuel model succession over time under treatment and no treatment scenarios: the postfire landscape is comprised of bare ground (fuel model NB9), sparse grass (GR1), and low load compact conifer litter (TL1). With no treatment, bare ground succeeds to moderate load grass-shrub (GS2), then to high load shrub (SH5). Sparse grass succeeds to moderate load shrub (SH2), then to high load shrub. Low load compact conifer litter succeeds either to low load shrub (SH1) then to high load shrub, or to long needle litter (TL8) then to very high load timber-shrub (TU5). After browse species planting, bare ground succeeds to moderate load shrub (SH2), then to high load shrub (SH5). After dead tree removal, reforestation and/or browse species planting, low load compact conifer litter (TL1) succeeds either to very high load timber-shrub (TU5), or to long needle litter (TL8) then to high load shrub (SH5).

Analysis Indicators

The first indicator in this analysis is flame length, as predicted for each standard fire behavior fuel model under 90th percentile weather and fuel moisture conditions (Table 1). Flame length directly affects fire suppression tactics and capabilities, and is thus an important indicator of the likelihood of successful fire control efforts. Flame length is analyzed using four categories corresponding to the effort and resources required to attack a fire (Table 2) (NWCG 2013). Flame length is a measure of fire intensity, which in turn affects fire severity particularly in timber fuel models (i.e. vegetation mortality).

The second indicator is fuel loading in small material (less than 3 inches in diameter) as determined by the standard fire behavior fuel models (Scott and Burgan 2005). Fuel loading has a direct effect on fire behavior, making it a very useful indicator of fuels reduction effectiveness. Table 3 shows fuel loads associated with each fuel model. Fuel loading of large material (greater than 3 inches in diameter) has an different effect from that of smaller material as this larger material takes longr to ignite and is likely to result in slower burning. These larger fuels reduce fire behavior overall but fuel loading of these materials is a useful measure of fuel reduction effectiveness because of the potential effects of soil and to suppression efforts. Fuels greater than 3 inches in diameter will burn for longer periods of time, causing addition heat transfer to the soil and increased potential for soil sterilization. Suppression efforts are more difficult because these larger fuels create an obstacle and safety hazard for fire personnel; often removal of these fuels is necessary to allow construction of control lines. Longer burning time requires additional effort to secure control lines and increases the potential for spot-fires. High large fuel loads reduce suppression resource effectiveness and the safety of firefighters. For the purpose of this analysis, under normal conditions (natural fire regimes) fuel loading ofr early and mid-succession vegetation ranges from 1.5 to 10 tons per acre (LANDFIRE 2007, Anderson 1982). Excess fuel loads of material greater than 3 inches in diameter are represented by 10 tons per acre or greater.

Fire severity is the third indicator, which will be represented by differences in fire severity acreage, as determined by professional assessment of flame lengths predicted under the modeled fuel moisture and weather scenario most similar to local 90th percentile conditions using the standard fire behavior fuel models (Scott and Burgan 2005). Fire severity describes the effects of fire on vegetation should a wildfire occur. It is related to vegetation mortality expected during a wildfire. For this analysis, fire severity is rated as high or low. Low fire severity is the result of low flame lengths (generally less than 8 feet in timber fuel types). This resembles an underburn with ground vegetation burned but large conifers remaining alive. High fire severity is the result of high flame lengths (generally more than 8 feet in timber fuel types). High severity fire kills nearly all of the large conifers and may lead to reduced re-sprouting of brush. Table 3 displays the various fuel models within the project area and the fire severity type with each fuel model

Table 1: 90th percentile weather and fuel moisture conditions

Factor	Local 90th Percentile Conditions	Modeled Scenario
1 Hour Fuel Moisture (%)	3	3
10 Hour Fuel Moisture (%)	3	4
100 Hour Fuel Moisture (%)	6	5
Live Herbaceous Fuel Moisture (%)	7	60
Live Woody Fuel Moisture (%)	60	90
Wind Speed (mph)	9	9

Table 2: Influence of flame length on effectiveness of fire control efforts

Flame Length	Interpretation
0-4	Fires can generally be attacked at the head or flanks by persons using hand tools. Handline should hold the fire.
4-8	Fires are too intense for direct attack on the head by persons using hand tools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8-11	Fire may present serious control problems including torching, crowning and spotting.
11+	Crowning, spotting, and major runs are common. Control efforts at the head of the fire are ineffective.

Table 3: Fuel load (in material less than 3 inches in diameter), predicted flame length, and predicted severity by fuel model

Fuel Model	Total Fuel Load in tons/acre <3" diameter	Flame Length in feet	Predicted Severity
NB9 (99)	0	0	N/A
GR1 (101)	0.4	2.5	Low
GS2 (122)	2.6	8.5	High
SH1 (141)	1.95	0.9	Low
SH2 (142)	8.35	7.0	Low
SH5 (145)	8.6	21.0	High
TU5 (165)	14	11.0	High
TL1 (181)	6.8	0.8	Low
TL8 (188)	8.3	5.8	Low

Table 4: Description of Fuel Models

NB9 (99)	**Bare Ground**	Land devoid of enough fuel to support wildland fire spread is covered by fuel model 99. Such areas may include gravel pits, rock outcroppings, and so forth. No fire effects are predicted.
GR1 (101)	**Short, Sparse Dry Climate Grass**	The primary carrier of fire in GR1 is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short and may be sparse or discontinuous. Spread rates and flame length are low creating a resilient mosaic of surface vegetation types with very limited overstory conifer mortality. Low severity wildfire effects are predicted.
GS2 (122)	**Moderate Load, Dry Climate Grass-Shrub**	The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate creating high mortality rates in surface and overstory vegetation including conifers. High severity wildfire effects are predicted.
SH1 (141)	**Low Load Dry Climate Shrub**	The primary carrier of fire in SH1 is woody shrubs and shrub litter. Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate is very low; flame length very low creating a resilient mosaic of surface vegetation types with limited overstory conifer mortality. Low severity wildfire effects are predicted.
SH2 (142)	**Moderate Load Dry Climate Shrub**	The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate is low; flame length low creating a resilient mosaic of surface vegetation types with limited overstory conifer mortality. Low severity wildfire effects are predicted
SH5 (145)	**High Load, Dry Climate Shrub**	The primary carrier of fire in SH5 is woody shrubs and shrub litter. Heavy shrub load, depth 4-5 feet present. Spread rate very high; flame length very high. High severity wildfire effects are predicted
TU5 (165)	**Very High Load, Dry Climate Timber-Shrub**	The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate creating high mortality rates in surface and overstory vegetation; including conifers. High severity wildfire effects are predicted.
TL1 (181)	**Low Load Compact Conifer Litter**	The primary carrier of fire in TL1 is compact forest litter. Light to moderate load, fuels 1 to 2 inches deep present; may be used to represent a recently burned forest. Spread rate is very low; flame length very low creating a resilient mosaic of surface vegetation types with limited overstory conifer mortality. Low severity wildfire effects are predicted.

Spatial and Temporal Context

Spatial boundaries, for direct, indirect effects, and cumulative effects will be limited to project area. While vegetation can be affected by conditions that occur at the landscape level, such as an insect epidemic or wildfire, it is most significantly affected by changes in its immediate surroundings. Temporal bounding for effects will be modeled for effects extending 40 years following treatment because this is required in the Forest Plan (standards 22-16, page 4-63). Effects will be modeled immediately after treatment (considered short-term effects), 20 years after treatment (considered mid-term effects), and 40 years after treatment (considered long-term effects). This is an adequate time frame in which to model differences between alternatives.

Affected Environment

Historically, the majority of the project area consisted of open mature ponderosa pine stands with pockets of younger regenerating ponderosa pine (LANDFIRE 2010). The exception was the area of Little Deer Mountain which provided an environment for incense cedar and varying degrees of white fir and Douglas fir. Conifer stands were maintained at sustainable levels by frequent low intensity wildfire which encouraged the development of shade intolerant and fire resistant species such as ponderosa pine. Shrubs and grasses were common and in various stages of development corresponding to frequent low intensity fire. Dominant shrub species included bitterbrush (*Purshia tridentata*) in openings of shallow soils, mountain mahogany (*Cercocarpus ledifolius*) in rocky areas and manzanita (Arctostaphylos spp.) also in openings. Idaho fescue (Festuca idahoensis) appears to have been the most prevalent native grass. 1944 aerial photos show most of the Goosenest Ranger District was selectively harvested of mature pine causing most stands prior to the Little Deer fire to be in a mid-seral development with a scattering of larger remnant trees (mostly pine). In the 114 years prior to the Little Deer Fire, there are 35 recorded fires in the project area which have burned 240 acres. This is less than the expected acreages and number of fires under reference fire conditions. Most of the project area is vegetation (ponderosa pine) that historically supported fire return intervals of 13 years, resulting in low fuel loads, low flame lengths, and low fire severity. When the 2014 Little Deer fire occurred, the area had missed several fire return intervals. With the exclusion of frequent fires, stands attained high stocking levels and fuel loads represented by high severity fuel models, providing conditions conducive to wildfires such as the 2014 Little Deer fire which exhibited high flame lengths and high severity fire effects. Brush and timber fuel models prior to the Little Deer fire were also represented as high severity fuel models throughout most of the project area as analyzed in the Harlan EA fuels report, which overlaps a portion of the Little Deer fire. Past cattle grazing has had little effect on the predicted severity of pre-fire fire fuel models.

To summarize, pre-fire fuel models were altered by past timber harvest and fire suppression causing predicted high severity fire effects throughout the project area. About 46 percent of the project area burned with high severity effects and 36 percent with moderate severity effects. Due to lack of mature trees for a seed source, natural regeneration over most of the area will not occur in a reasonable time frame. It is estimated that there will be an average of about 28 tons per acre of snag material greater than 3 inches scattered throughout the project area, based on conditions measured after the nearby 2009 Tennant fire. The actual timing of when the snag material will fall to the ground is uncertain, but based on observed mortality and snag fall two miles to the east (2009 Tennant fire) it is estimated that 60% of pine snag material will be on the ground in 5 years. As snags fall some of the woody material will decompose. The amount of decomposition is related to a variety of factors including the effects of insects and future weather trends. As decomposition occurs some of the larger diameter material (greater than 3 inches) will be converted to future organic materials. Dead fuels greater than 3 inches in diameter are slow to ignite and are generally result in low fire severity to vegetation, but can burn for a greater duration causing soil heating, which damages organic material in the ground and immediately above the ground. An increase in these fuels relates to higher soil severity and can lead to cambium mortality in the boles of live trees, but these fuels usually do not increase the fire severity to vegetation. Fuel loads for dead material less than 3 inches in diameter relate directly to fire behavior within the flaming front of the fire. Increases in these fuels generally result in an increase in fire severity, in suppression effort needed to control fires, and in the potential for passive and active crown fires. An increase in potential for crown fires increases the potential for mortality due to crown consumption (Brown and Kapler, 2000). Research shows that when activities reduce surface fuels, those activities decrease the chances that surface fires will be able to ignite ladder fuels and canopy fuels. The most effective strategy for reducing crown fire occurrence and severity is to (1) reduce surface fuels, (2) increase height to live crown, (3) reduce canopy bulk density, and (4) reduce continuity of the forest canopy (Graham et al. 2004).

Planting brush within conifer stands would not follow natural succession pathways and would not create a setting that complements ecological processes and promotes long-term sustainability. This is due to brush usually taking 9 years to reestablish naturally, whereas if planted it will compete with the conifers. Planting of brush in openings and rocky areas, and in areas that were previously un-forested would more closely follow natural succession pathways.

Environmental Consequences

This section analyzes the effects that each alternative has on the acreage occupied by each fuel model, and the relationship of these acreages to the three analysis indicators (flame lengths, fuel loads, and fire severity).

Alternative 1

Direct Effects and Indirect Effects

Under alternative 1 there would be no project actions taken. As noted in the vegetation report, vegetation would be dominated by shrubs for an extended time period. Conifers would be very slow to establish due to the lack of nearby seed sources. Potential high severity unplanned fires would promote continued dominance of shrubs until a seed source for conifers can become established.

The additional fuel loads from the snag material would add to the fuel load from the vegetation that established naturally but would remain a low severity fuel model if not mixed in with a high severity fuel model (Tables 5A, 5B, and 5C, Figures 1 and 2). The actual timing of when the snag material would fall to the ground is uncertain, but based on observed mortality and snag fall two miles to the east (2009 Tennant fire) it is estimated that 60% of pine snag material will be on the ground in 5 years, and that there will be 28 tons per acre of dead material greater than 3 inches from fire killed trees with a total of 116,200 tons project wide. As snags fall and woody material decomposes, larger diameter material (greater than 3 inches) will be converted to fuels which are slow to ignite; this will generally result in low fire severity to vegetation but higher severity to soils. Fuel loads for dead material less than 3 inches in diameter relate directly to fire behavior within the flaming front of the fire. Increases in these fuels generally result in an increase in fire severity, in suppression effort needed to control fires, and in the potential for passive and active crown fires. An increase in potential for crown fires increases the potential for mortality due to crown consumption (Brown and Kapler, 2000).

Table 5A: Fire severity distributions currently for alternative 1

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
GR1 (101)	35	1%	2.5	.4	LOW
TL1 (181)	3895	93%	0.8	6.8	LOW
NB9 (99)	225	6%	0	0	LOW
Area-Weighted Average	--	--	0.8	6.3	LOW

Table 5B: Fire severity distribution after 20 years for alternative 1

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
GS2 (122)	226	6%	8.5	2.6	HIGH
SH1 (141)	2640	63%	0.9	1.95	LOW
SH2 (142)	35	1%	7.0	8.35	LOW
TL8 (188)	1254	30%	5.8	8.3	LOW
Area-Weighted Average	--	--	2.9	3.96	LOW

Table 5C. Fire severity distribution after 40 years for alternative 1

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
SH5 (145)	2900	70%	21.0	8.6	HIGH
TU5 (165)	1255	30%	11.0	14	HIGH
Area-Weighted Average	--	--	18.0	10.2	HIGH

Cumulative Effects

The effects of past actions have been included in the description of the affected environment. There are some reasonable foreseeable future actions within the project area that will result in reduced potential for high intensity wildfires; these are limited to areas in and around the other vegetation treatments on private lands. For example, salvage harvest and live tree planting is likely to be implemented on private land; the potential for high intensity wildfire is likely to decrease around these private lands if trees outcompete and shade brush, especially if herbicides are used to the eliminate brush using brush species. The impacts of ongoing cattle grazing in the Horsethief grazing allotment are considered in this cumulative effects analysis but grazing is not likely to have a measurable effect on the analysis indicators for fire and fuels and is not likely to contribute to changes in fire severity. There are no foreseeable future actions that will reduce the probability of fire entering the project area from outside. Adding the effects of alternative 1 to the effects of private land treatments is not likely to produce substantial cumulative effects; adding the effects of cattle grazing to the effects of alternative 1 are not likely to produce substantial cumulative effects.

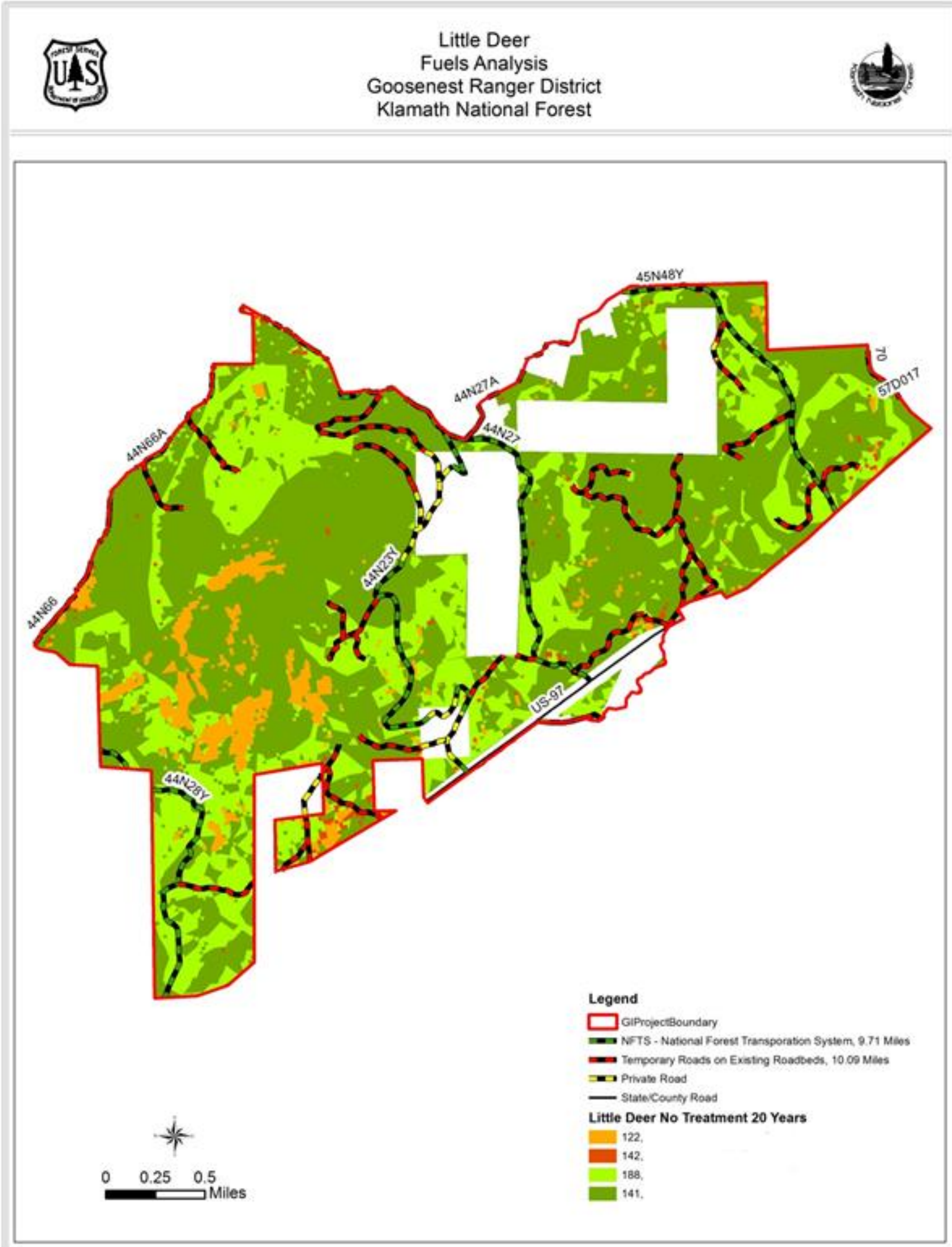

Figure 1: Alternative 1 fuel models at 20 years

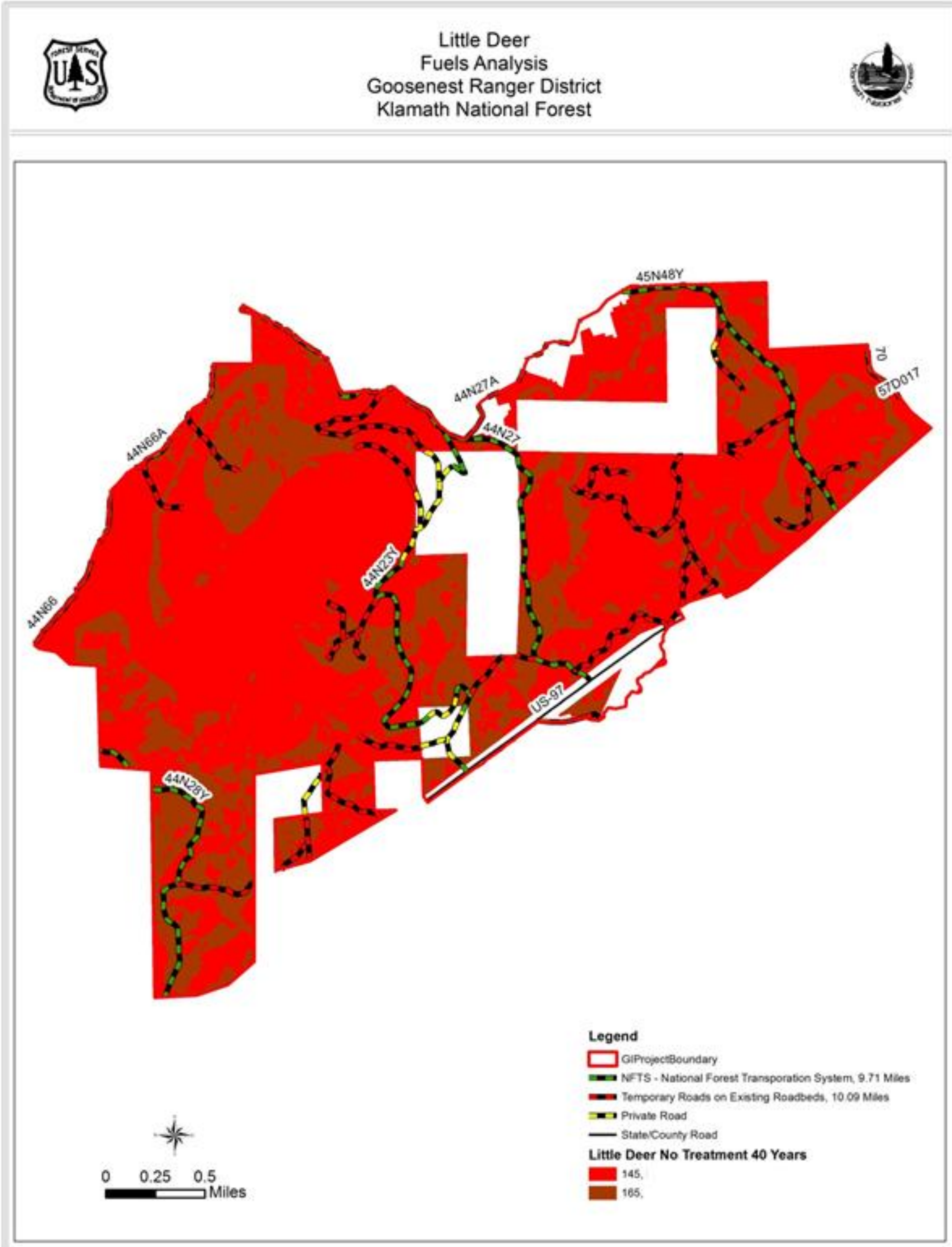

Figure 2: Alternative 1 fuel models at 40 years

Alternative 2

Direct and Indirect Effects

Alternative 2 proposed treatments are described in Chapter 2 of the EA.

The effects of these treatments will be to promote conditions where conifer and browse species will re-establish within a shorter time frame than Alternative 1. Browse species planting will provide areas where fire behavior will be more severe, especially within conifer stands. Conifer stands would have high severity wildfire similar to that of the Little Deer fire described above. Limited snag retention will reduce the probability of spotting. High severity predicted fuel models will limit suppression efforts needed to contain a fire to indirect tactics (greater than 8 foot flame lengths) and not allow direct attack (Tables 6A, 6B and 6C, Figures 3 and 4). Therefore, adding the effects of continued browse species planting is likely to affect the project area's ability to move toward desired conditions. This alternative would remove an estimated 50,988 tons per acre of dead material greater than 3 inches from fire-killed trees from the total of 116,200 tons (43 percent removal).

Table 6A: Fire severity distribution immediately after treatment with alternative 2

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
101	35	1%	2.5	.4	LOW
181	3894	94%	0.8	6.8	LOW
99	226	5%	0	0	LOW
Area-Weighted Average	--	--	0.8	6.4	LOW

Table 6B: Fire severity distribution after 20 years with alternative 2

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
122	191	4%	8.5	2.6	HIGH
141	1496	36%	0.9	1.95	LOW
142	71	2%	7.0	8.35	LOW
165	1143	28%	11.0	14.0	HIGH
188	1254	30%	5.8	8.3	LOW
Area-Weighted Average	--	--	5.6	7.38	LOW

Table 6C: Fire severity distribution after 40 years with alternative 2

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3")	Fire Severity Type
145	1758	42%	21.0	8.6	HIGH
165	2397	58%	11.0	14.0	HIGH
Area-Weighted Average	--	--	15.2	11.7	HIGH

Cumulative Effects

Cumulative effects are the same as alternative 1.

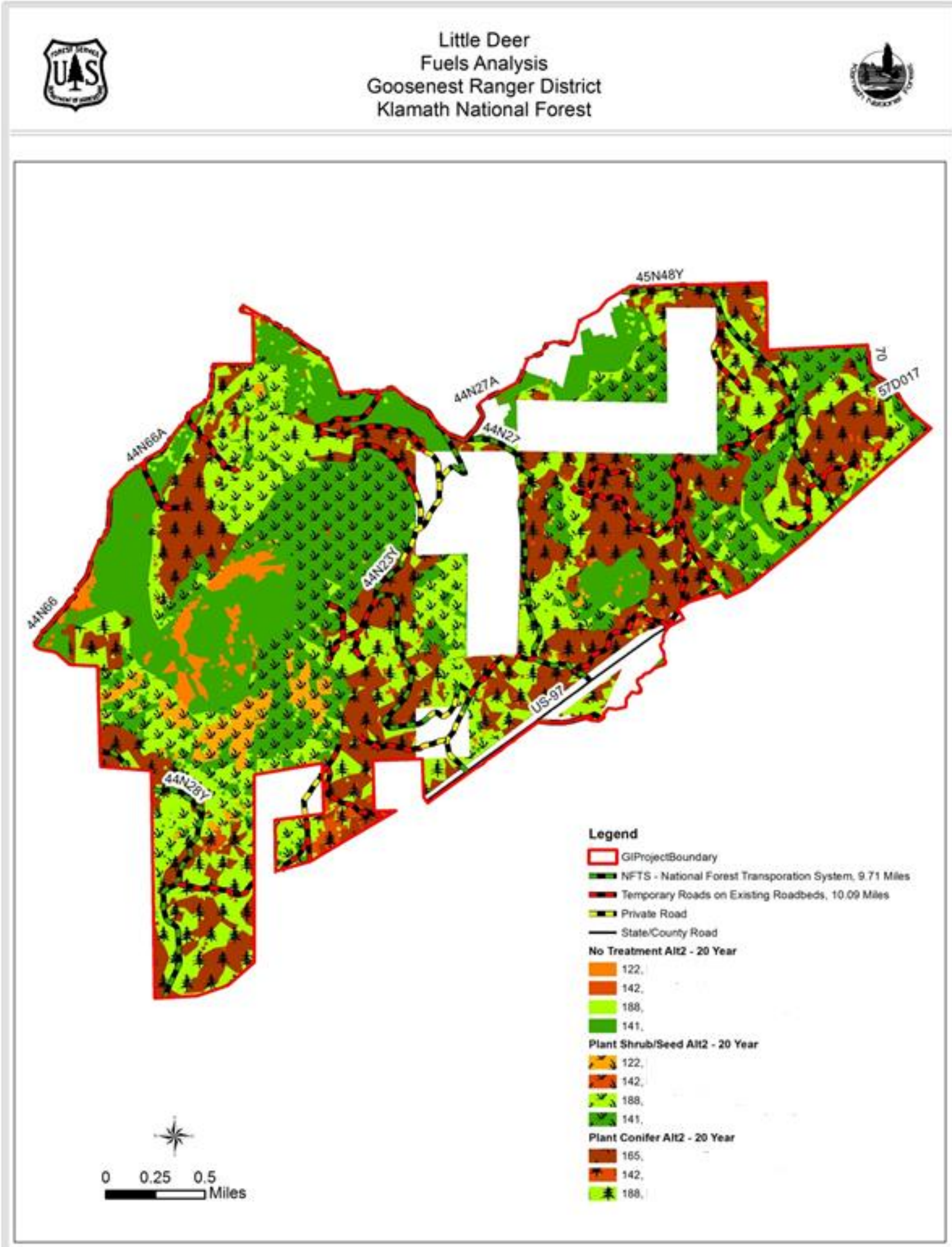

Figure 3. Alternative 2 fuel models at 20 years

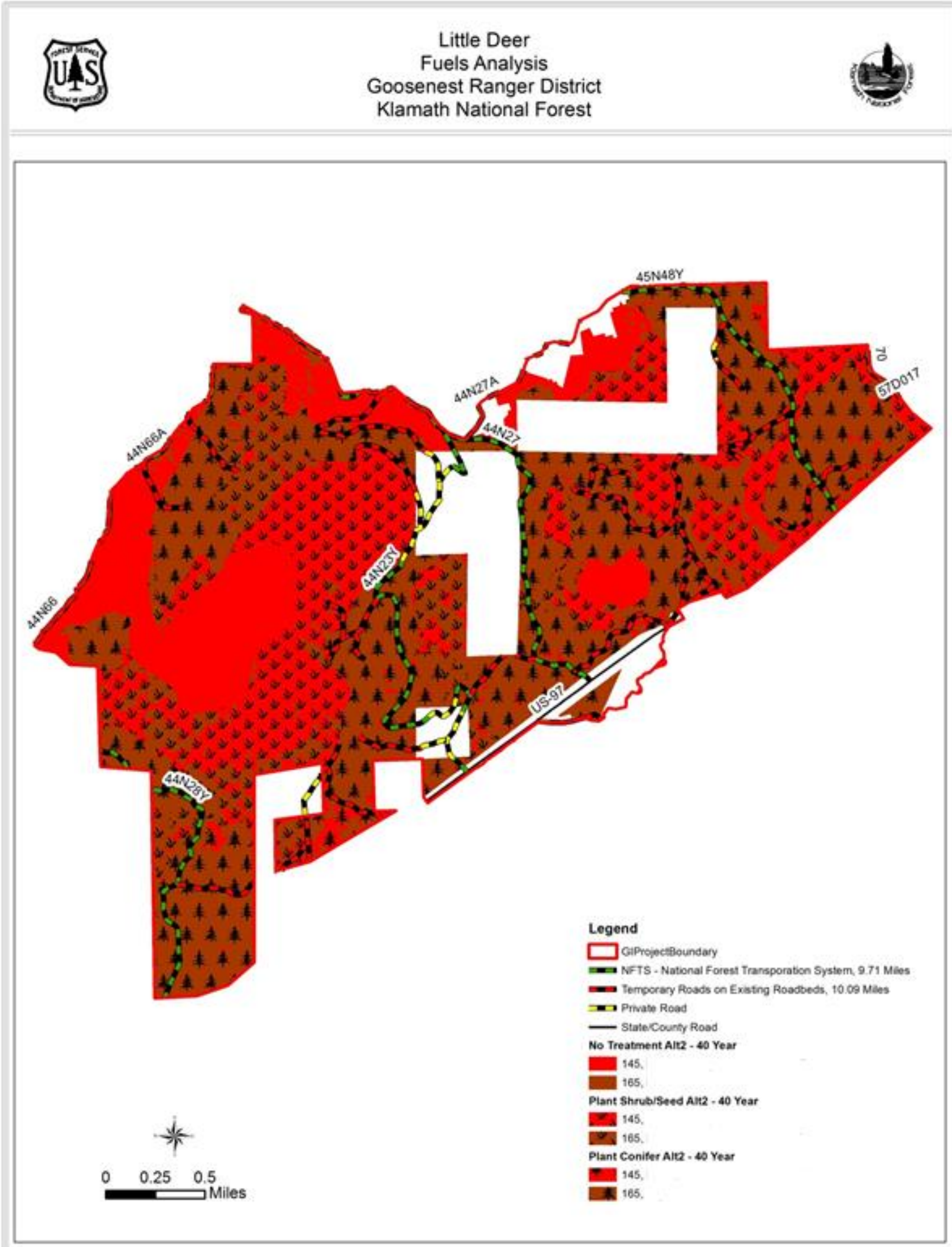

Figure 4. Alternative 2 fuel models at 40 years

Alternative 3

Direct and Indirect Effects

Alternative 3 proposed treatments are described in Chapter 2 of the EA

The differences between alternative 2 and 3 are that less acreage will be treated by dead tree removal, conifer reforestation, and planting of browse species, and additional snags will be left on site. This alternative would remove an estimated 44,744 tons per acre of dead material greater than 3 inches from fire killed trees (38 percent removal), 6,244 less tons per acre than alternative 2.The effects of these treatments will be similar to those of alternative 2 (Tables 7A, 7B and 7C, Figures 5 and 6).

Table 7A. Fire severity distribution immediately after treatment with alternative 3

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3”)	Fire Severity Type
101	35	1%	2.5	.4	LOW
181	2311	55%	0.8	6.8	LOW
99	1809	44%	0	0	LOW
Area-Weighted Average	--	--	0.5	3.7	LOW

Table 7B: Fire severity distribution after 20 years with alternative 3

Fuel Model	Acres	Percentage of Project Acres	Flame Length (Feet)	Fuel Load (Tons Per Acre <3”)	Fire Severity Type
122	199	4%	8.5	2.6	HIGH
141	1749	41%	0.9	1.95	LOW
142	61	1%	7.0	8.35	LOW
165	892	21%	11.0	14.0	HIGH
188	1254	33%	5.8	8.3	LOW
Area-Weighted Average	--	--	5.0	6.67	LOW

Table 7C: Fire severity distribution after 40 years with alternative 3

Fuel Model	Acres	Percentage of Project Acres	Flame Length (feet)	Fuel Load (Tons Per Acre <3”)	Fire Severity Type
145	2010	49%	21.0	8.6	HIGH
165	2145	51%	11.0	14.0	HIGH
Area-Weighted Average	--	--	15.9	11.35	HIGH

Cumulative Effects

Cumulative effects are the same as alternatives 1 and 2.

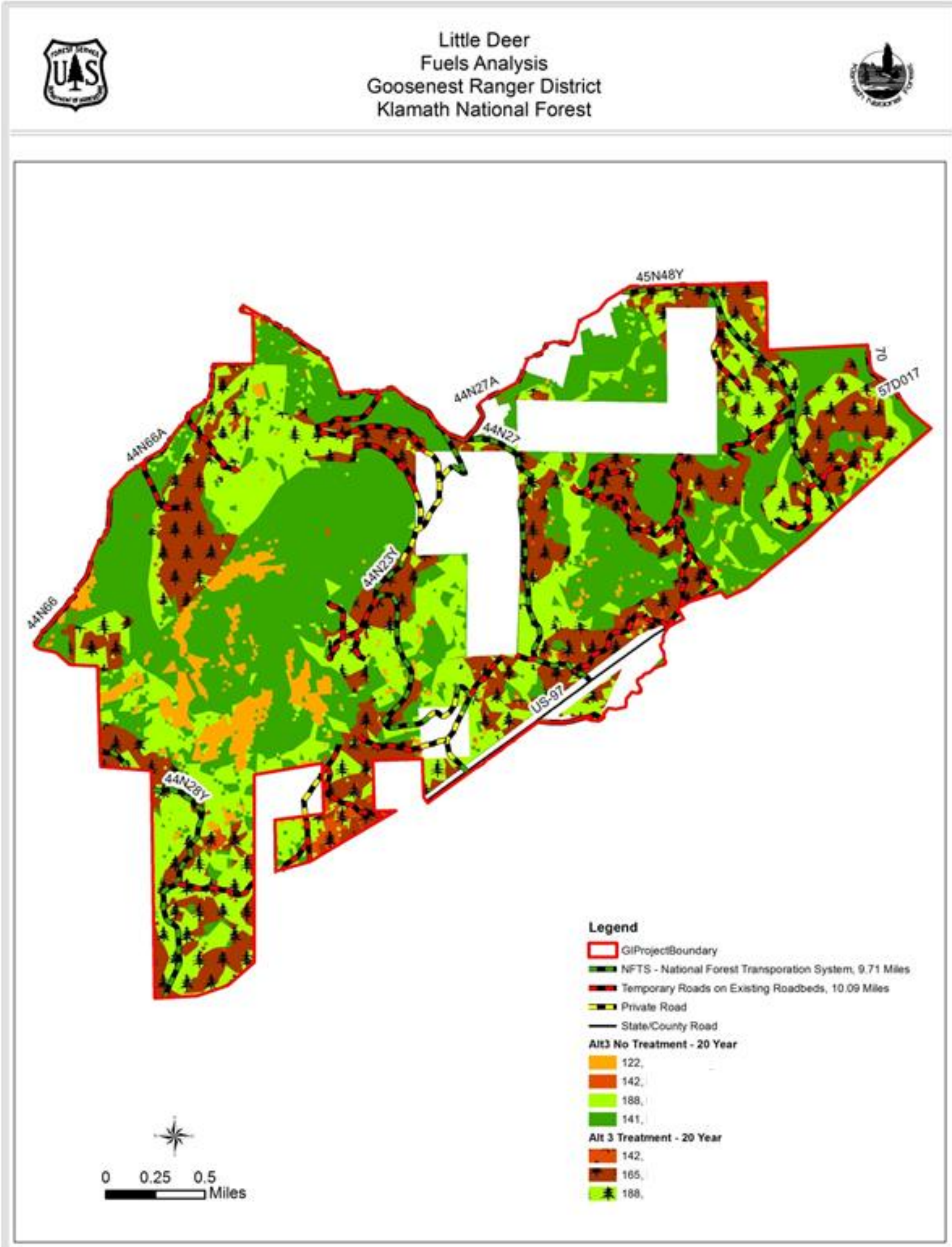

Figure 5: Alternative 3 fuel models at 20 years

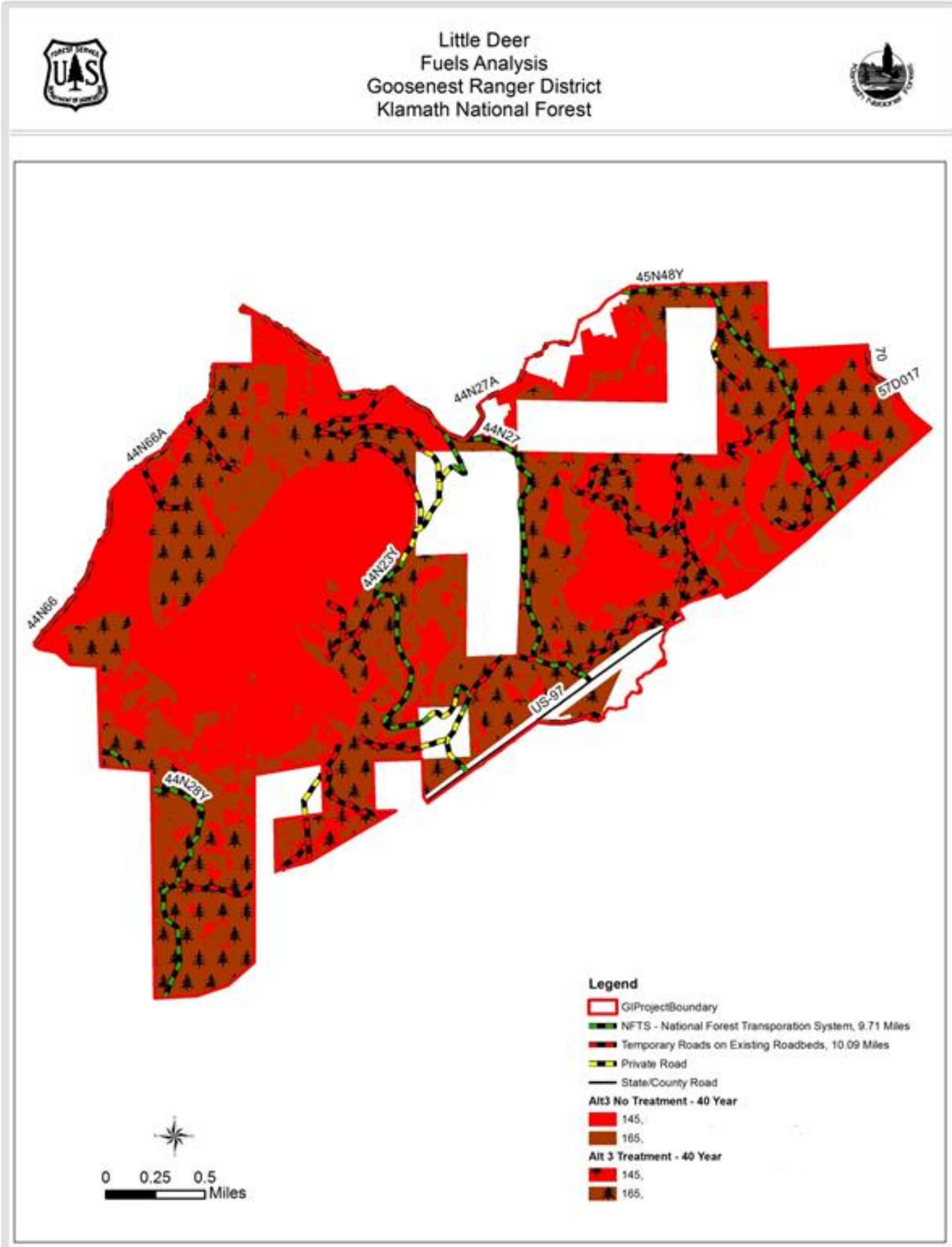

Figure 6: Alternative 3 fuel models at 40 years

Comparison of Effects

In the short term, alternatives have little difference in flame lengths, fuel loads, or proportion of high fire severity due to all surface vegetation being removed by the Little Deer Fire, and post-treatment vegetation just beginning to establish. Alternative 2 has slightly higher fuel loads of small material and flame lengths due to a greater number of acres treated by dead tree removal and brush planting, while alternative 3 has slightly lower fuel loads from small material and lower flame lengths due to the lower acreage treated by dead tree removal and brush planting. In the short term, all three alternatives will have flame lengths conducive to direct attack by handcrews and will have only low severity fire effects across the landscape. Short-term effects are displayed in table 8A.

Table 8A: Comparison of short term effects of alternatives on fire and fuel analysis indicators

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3")	Fuel Load (Ton Per Acre >3")	Acres of High Severity	Percentage of High Severity Acres
1	0.8	6.3	0	0	0%
2	0.8	6.4	0	0	0%
3	0.5	3.7	0	0	0%

After 20 years, Alternative 1 will have lower small material (less than 3 inches diameter) fuel loads, flame lengths, and fire severity risk on 63% of the project due to no creation of activity fuels associated with dead tree removal or brush planting. This will result in a primarily low severity brush fuel model type within the high severity burned conifer areas of the Little Deer fire, and no new conifer establishment through artificial reforestation methods. In action alternatives, planting browse species within the conifer planting areas will create a high severity fuel model due to brush and trees being mixed together. Of the action alternatives, alternative 3 has slightly lower small material (less than 3 inches diameter) fuel loads, flame lengths, and acreage of high severity fire effects due to less acreage being artificially reforested and planted with browse species which results in less area dominated by fuel model TU5 (timber with shrub understory). Alternative 2 will have the lowest large-fuel load followed closely by alternative 3 with alternative 1 having fuel loads of large material (greater than 3 inches diameter) in excess of normal conditions. Alternative 1 will have flame lengths conducive to direct attack by handcrews but fuel loads of large material (greater than 3 inches in diameter) will decrease firefighter performance effectiveness and safety. Alternatives 2 and 3 will require use of equipment to effectively suppress a fire, but will have increased firefighter effectiveness and safety. Mid-term effects of alternatives are displayed in table 8B.

Table 8B: Comparison of effects of alternatives on fire and fuel analysis indicators after 20 years

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3")	Fuel Load (Ton Per Acre >3")	Acres of High Severity	Percentage of High Severity Acres
1	2.9	4.0	24	226	6%
2	5.6	7.4	10	1334	32%
3	5.0	6.7	11	1091	25%

After 40 years, alternatives will have little difference in small-fuel loads (less than 3 inches in diameter), flame lengths, and proportion of high fire severity due to all surface vegetation missing three fire return intervals and being in a condition similar to that which was present prior to the Little Deer fire. The difference in flame lengths and fuel loads among the alternatives is primarily due to the different amounts of planting between alternatives 2 and 3 which affects the ratio of brush and timber understory fuel models. Alternative 1 will still have the greatest fuel load of large material (greater than 3 inches in diameter). All three alternatives would have flame lengths exceeding the threshold for direct attack, and would have high severity fire effects across the entire landscape as displayed in table 8C.

Table 8C: Comparison of effects of alternatives on fire and fuels analysis indicators after 40 years

Alternative	Flame Length (feet)	Fuel Load (Tons Per Acre <3”)	Fuel Load (Ton Per Acre >3”)	Acres of High Severity	Percentage of High Severity Acres
1	18.0	10.2	18	4155	100%
2	15.2	11.7	6	4150	100%
3	15.9	11.4	6	4179	100%

Compliance with law, regulation, policy, and the Forest Plan

All action alternatives comply with laws, regulations, policy, and direction of the Forest Plan as they relate to the fire and fuels resource as displayed in the Forest Plan consistency checklist, available on the project website.

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